
HOSPITAL
HAI

How serious of HAI in Thailand

%S

≥ 90 | 80-89 | 70-79 | 50-69 | < 50

Percentage of susceptible Organisms Isolated From All Specimen, 49 hospitals, Jan - Sep 2019

Organism	TOTAL ISOLATES	BETA - LACTAMS																			CARBAPENEMS			POLY MYXINS	QUINOLONES			AMINOGLYCOSIDES			GLYCOPEPTIDES			MISCELLANEOUS								
		PENICILLIN	PENICILLIN BY MIC	AMPICILLIN	AMOXICILLIN/ CLAVULANIC ACID	AMPICILLIN / SULBACTAM	PIPERACILLIN / TAZOBACTAM	CEFADUXIN (A)	CEFADUXIN (U)	CEFUROXIME SODIUM (parenteral)	CEFUROXIME SODIUM (Oral)	CEFOPERAZONE / SULBACTAM	CEFOTAXIME	CEFOTAXIME BY MIC	CEFTAZIDIME	CEFTAZIDIME BY MIC	CEFTRIAXONE	CEFTRIAXONE BY MIC	CEFEPIME	OXACILLIN	CEFOXITIN	ERTAPENEM	IMIPENEM	MEROPENEM	COLISTIN BY MIC	CIPROFLOXACIN	CIPROFLOXACIN BY MIC	LEVOFLOXACIN	AMIKACIN	GENTAMICIN	GENTAMICIN 120 µg	VANCOMYCIN	VANCOMYCIN BY MIC	TEICOPLANIN	FOSFOMYCIN	CLINDAMYCIN	CLINDAMYCIN BY MIC	ERYTHROMYCIN	ERYTHROMYCIN BY MIC	NITROFURANTOIN (U)	CHLORAMPHENICOL	CO-TRIMOXAZOLE	TETRACYCLINE
Acinetobacter calcoaceticus-baumannii complex	22,339			R	R	30.9 (3517)	29.8 (12388)						4.9 (9998)	14.9 (3360)	30.5 (14694)	26.5 (4436)	5.3 (6703)	17.3 (3131)	35.5 (1021)			R	29.8 (11036)	31.6 (13750)	97 (4105)	32.6 (13732)		31.9 (7840)	50.7 (14300)	42.5 (12641)					R						R	43 (9929)	19.3 * (140)
(ICU)	3,963			R	R	21.8 (542)	20 (2197)						2.4 (1121)	9.3 (819)	22.6 (2420)	16.4 (1103)	2.8 (1112)	8.9 (777)	18.5 (292)			R	17.9 (1889)	22.5 (2381)	95.6 (886)	24.4 (2313)		24.7 (1872)	43.5 (2407)	32.9 (2234)					R						R	37 (1765)	- *
(inpatient)	11,844			R	R	31.9 (1788)	29.4 (5228)						4.7 (3650)	13.8 (2192)	29.9 (7493)	26.1 (2740)	5.6 (2872)	16.9 (1910)	42.4 (328)			R	29.8 (5027)	31.5 (7098)	97.1 (2561)	32.1 (6757)		33.4 (4076)	49.9 (6963)	42.1 (5647)					R						R	41.2 (4849)	14.3 * (42)
(outpatient)	856			R	R	54 (83)	57.6 (436)						13.6 (177)	23.8 (172)	55.2 (591)	49.5 (194)	13.3 (241)	28.9 (173)	58 (50)			R	62.3 (244)	60.7 (478)	96.8 (185)	58.9 (474)		62.5 (176)	71.1 (481)	67.8 (380)					R						R	65.6 (311)	- *
Acinetobacter spp.	1,619					74.8 (329)	77.3 (888)						35.8 (846)	43.5 (170)	68 (1084)	60.1 (223)	37.3 (582)	53.5 (170)	76.9 (65)				73.5 (773)	74.8 (968)	95.5 (176)	74.1 (1041)		80 (531)	80.2 (1051)	73.4 (975)												65.4 (739)	- *
Aeromonas hydrophila	498						89.4 (151)			82.4 (51)			85.4 (219)	83.8 (80)	87.2 (196)	89 (116)	89.8 (177)	83.2 (101)	-		30.6 (62)	64.8 (125)	53.4 (116)	89.3 (177)		91.8 (244)		94 (97)	98.1 (207)	96.5 (229)										94.6 (37)	86.1 (274)	71.4 (49)
Burkholderia cepacia complex	460			R	R	R	R						R r	R r	93.9 (295)	81 (100)	R r	R r	R			R	R r	91.8 (243)	R			- *	R r	R r	R r				R						- *	93 (242)	
Burkholderia mallei	9															-							- *																		- *
Burkholderia pseudomallei	1,432				- *											96.7 (517)							96.8 * (348)																	- *	- *
Citrobacter freundii	726			R	R	R	87.8 (368)	R	R	R	R	83.4 (241)	71.1 (425)	47 (132)	74.4 (472)	56.3 (151)	69.8 (252)	51.6 (122)	87.6 (37)		R	93.4 (366)	80.2 (316)	93.7 (426)		71 (421)		76.4 (161)	98.2 (446)	88 (429)									-	-	76.3 (447)	-
Enterobacter cloacae	4,461			R	R	R	83.3 (2273)	R	R			84.4 (1771)	64.6 (2330)	62 (932)	66.2 (2800)	61.8 (781)	66 (1835)	65.5 (579)	98.1 (229)		R	92.1 (2030)	92.8 (1169)	95.3 (2547)	83.1 #1 (532)	70.8 (2573)		85.1 (1018)	97.5 (2637)	82.6 (2607)									51 (51)	-	73.1 (2439)	-
Enterobacter spp.	1,794			4.3 (877)	10.2 (823)	36.4 (217)	85.3 (1089)	7.5 (318)	16.4 (67)	50.4 (369)	-	85.3 (789)	92.9 (1082)	56.7 (238)	71.6 (1320)	66.8 (241)	67.5 (968)	57.1 (203)	82.9 (124)		16.6 (290)	92.2 (1096)	80.2 (646)	95.2 (1155)		72.9 (1065)		88.7 (626)	97.2 (1307)	86.3 (1283)									-	-	76.2 (1108)	57.8 (45)
Escherichia coli (all isolates)	41,311			15.2 (20600)	58.3 (21343)	59 (5172)	91.8 (22741)	34.4 (4648)	52.4 (6484)	53.4 (9966)	-	90.8 (16366)	55.6 (24127)	51.2 (5843)	66 (28106)	57.2 (7509)	57.6 (19028)	52.2 (5317)	58.3 (2333)		90.3 (7465)	96.9 (21457)	96.6 (19746)	97.3 (25994)	97.5 #1 (6081)	41.1 (25165)		48.4 (10377)	98.5 (26873)	67.7 (26665)									94.6 (1935)	85.5 (55)	45.1 (24014)	36.5 (806)
(Urine-inpatient)	10,534			12.8 (5149)	65.1 (5935)	52.2 (1532)	89.6 (5481)		49.3 (2868)	46.3 (1079)	-	89.7 (3735)	49.7 (5810)	42.6 (1823)	61.5 (7045)	57.4 (1849)	51.2 (4894)	42 (1564)	57.2 (705)		87 (1139)	95.6 (5656)	95.9 (4667)	96.3 (6332)	97.5 #1 (1525)	34.4 (6302)		40.4 (2931)	98.3 (6557)	64.3 (6640)					98.7 (1908)				94.8 (821)	-	42 (6589)	36.4 (184)
(Urine-outpatient)	3,934			15.5 (1936)	67.6 (2914)	59.2 (424)	93.9 (2282)		59 (1007)	52.3 (302)	-	94.5 (1447)	57.4 (2177)	46.2 (707)	68.6 (2914)	65.6 (730)	60.4 (2366)	48.3 (629)	49.4 (261)		88.9 (733)	98.4 (2158)	99 (1571)	98.9 (2639)	97.4 #1 (570)	30 (2615)		37.3 (1143)	98.9 (2708)	65.9 (2542)					99.1 (585)				91.1 (383)	-	42.2 (2488)	45.5 (110)

Source: National Antimicrobial Resistance Surveillance Center, Thailand

XENEX® DISINFECTION SYSTEMS™

HAIs Can Impact Patients of Any Age

Impact to the **hospital**:

- Length of stay/lost bed days
- Patient mortality
- Lost Medicare reimbursement
- Lower census

Impact to the **patient**:

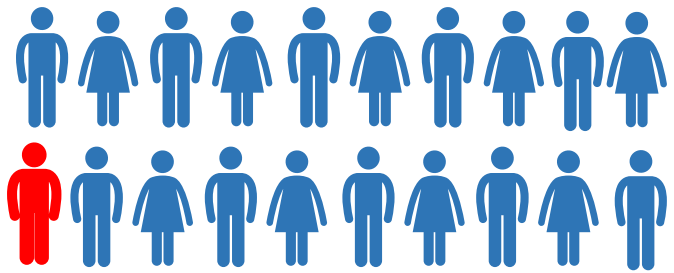
- Expense for treatment
- Long-term health - potentially death
- Physical & psychological
- Career impact

Living with MRSA

Rosie Bartel's story…

- She acquired MRSA following knee replacement surgery
- To date she's had over 27 surgeries
- She's had to give up her teaching career and her mobility has been severely impacted
- Unable to stop the infection, she's lost her leg and now, part of her pelvis
- She continues to battle the complications of reoccurring MRSA infections
- In 2017, she acquired a *C. diff* infection that nearly took her life

HAI Impact: Both Financial and Human



1 in 20
patients in the U.S.
will contract an HAI.[1]

1 in 9
of those will die[1].

Annually, that's over:

2 Million
INFECTIONS

40 Billion
DOLLARS

274
PATIENTS
DEATHS PER DAY

Based on a systematic review and meta-analysis of seven studies from Southeast Asia, the pooled prevalence of overall HAIs in Southeast Asia is 9.0%.

Sources: www.ihi.org/Topics/HAI 2. www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_02.pdf 3. www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf

The Problem: Pathogens Don't Die

PERSISTENCE OF MICROBES ON DRY, INANIMATE SURFACES

Pathogen	Duration of Persistence
MRSA, MSSA	7 days – 12 months
VRE	5 days to > 46 months
C. diff spores	5 months
Acinetobacter	3 days to 5 months
E.coli	Up to 16 months
Klebsiella species	2 hours to 30 months
Pseudomonas aeruginosa	Up to 16 months
HIV	> 7 days
Influenza virus	1 – 2 days
Norovirus	Up to 7 days

Adapted from Kramer, A., Schwebke, I., & Kampf, G. (2006). How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infect Dis, 6, 130. doi:10.1186/1471-2334-6-130, Otter, J. A., Yezli, S., Salkeld, J. A., & French, G. L. (2013). Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings. Am J Infect Control, 41(5 Suppl), S6-11. doi:10.1016/j.ajic.2012.12.004, Havill, N. L., Boyce, J. M., & Otter, J. A. (2014). Extended survival of carbapenem-resistant Enterobacteriaceae on dry surfaces. Infect Control Hosp Epidemiol, 35(4), 445-447. doi:10.1086/675606

A Comprehensive Approach

Hand Hygiene

+

Antibiotic Stewardship

+

Environmental Cleaning

Manual Cleaning Leaves Pathogens Behind

High Touch Surfaces Cleaned In Manual Cleaning

Cleaned
48%

Not Cleaned
52%

High Touch Surfaces Disinfected In Manual Cleaning

Disinfected
60%

Poorly Disinfected
40%

Reference: (R) Carling P: Improving Cleaning of the Environment Surrounding Patients in 36 Acute Care Hospitals. Am J Infect Control 2008, vol. 29:11, pp 1035-1041.
(L) Carling P: Methods for assessing the adequacy of practice and improving room disinfection. Am J Infect Control 2013, 41:S20-25.

Efficacy of Disinfection During Manual Cleaning

Environmental Cleaning Study Results:

48% Of high touch surfaces are "cleaned" during manual cleaning

60% Of those high touch surfaces "cleaned" during manual cleaning were actually "cleaned and disinfected"

For Example…

100 If you sampled 100 surfaces after manual cleaning:

48 48 of those surfaces would be deemed "Clean" after manual cleaning.

29 Of those 48, ONLY 29 surfaces would be "Cleaned and Disinfected."

Reference: 1. Carling P: Improving Cleaning of the Environment Surrounding Patients in 36 Acute Care Hospitals. Am J Infect Control 2008, vol. 29:11, pp 1035-1041. 2. Carling P: Methods for assessing the adequacy of practice and improving room disinfection. Am J Infect Control 2013, 41:520-25.

Constraint of Strong Chemical cleaning

NHS staff at risk of inhaling toxic fumes from cleaning machines, investigation finds

Derek Baines, 51, used to work as a domestic supervisor at Morriston Hospital in Swansea

27 JULY 2019 • 9:30PM

NHS staff are at risk of inhaling toxic fumes from cleaning machines, a Telegraph investigation has found.

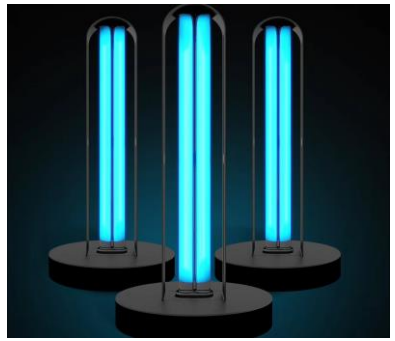
Employees claim that hospitals have been "gassing" them after they suffered nose bleeds, burning eyes and chest infections following exposure to hydrogen peroxide vapour.

NHS Trusts across the country could now face legal action from staff who operated "Deprox" machines without adequate training or protective gear.

Two domestic managers took made claims against their NHS Trust and won five figure pay-outs between them in settlements earlier this year.

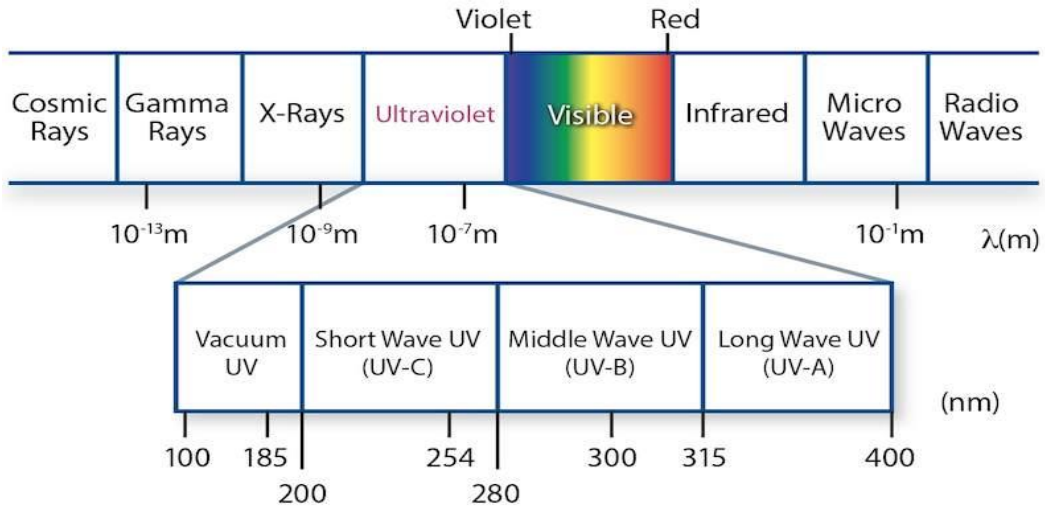
UVC technology

Sources	Xenon	Light Emitting Diodes (LED)	Mercury
Wavelength (nm)	Broad wavelength 200 - 315	Peak wavelength 266, 270, 275, 279*	Peak wavelength 253.7
Germicidal application *(with clinical evidences on HAI reduction)*	30+ publications	NA	Limited clinical evidence on HAI
Sporicidal effect (min)	5 min	No data	60 – 120 min
SARS-CoV-2 reduction	2 min, 99.99%	No data	No data
Mercury free	YES	YES	NO (5-200 mg)
Warm up time	Instantaneous	Instantaneous	15 min



Sources: *Kim SJ. and et al. Using UVC LED at wavelength of 266 to 279 nm to inactivate foodborne pathogens. App. And Environ. Microbiology 2015

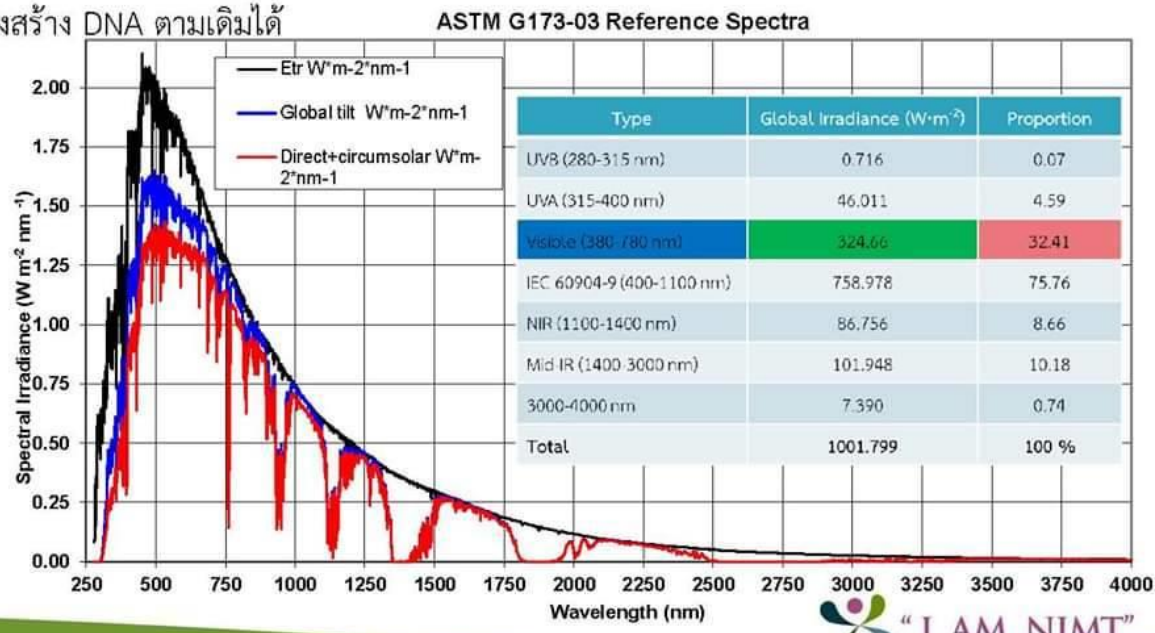
Fact of Mercury UV lamp emission spectrum



Wavelength (nm)	Name	Color	
184.5 Generate high	Ozone	Vacuum UV	
253.7		ultraviolet (UVC)	
365.4	I-line	violet	UVA
404.7	H-line	Indigo	
435.8	G-line	blue	Visible light
546.1		green	
578.2		yellow-orange	
650		red	

รังสียูวีในแสงแดดฆ่าเชื้อโรคได้หรือไม่ ?

ในแสงแดดมีสัดส่วนของแสงที่สามารถทำลายเชื้อโรคได้น้อย จึงต้องใช้เวลานานในการฆ่าเชื้อ อีกทั้งแสงแดดในช่วง UVA และ visible light สามารถซ่อมแซมโครงสร้างของเชื้อโรคได้ โดยเกิดเอ็นไซม์โฟโตไลเอส (Photolyase) ไปกระตุ้นทำให้ไทมีนไดเมอร์ (T และ T) แยกออกจากกัน และเกิดพันธะไฮโดรเจนระหว่าง T กับ A นิวคลิโอไทด์ของโครงสร้าง DNA ตามเดิมได้



Cidal effect from Mercury UVC require at least 24 hr.

MILITARY MEDICINE, 172, 6:616, 2007

Comparative Sporicidal Effects of Disinfectants after Release of a Biological Agent

- Bacillus anthracis is considered the most resistant spore formation microorganism. Spores of B. anthracis can maintain their viability in the environment for years
- It is extremely expensive, difficult , and time-consuming to eliminate spores of B. anthracis from a particular area
- All environmental material pieces were contaminated by bacterial spores, and applied with a number of sterilization methods as table
- The study showed sterilization by Mercury UVC of valuable archives and documents might be possible if they were kept under UV rays for at least 24 hours. In addition, fabric, wood, and protective suit samples which might be damaged during decontamination although be completely sterilized within 24-hr UV radiation

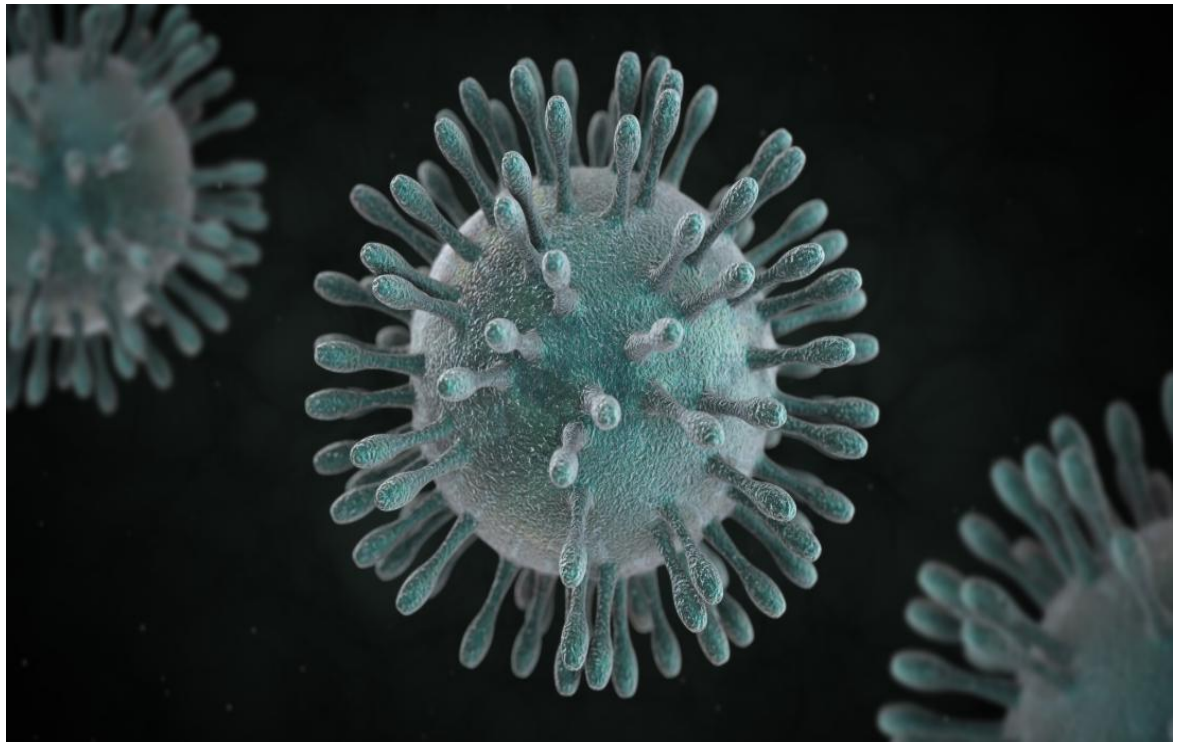
STERILIZATION METHODS AND APPLICATION TIMES

Sterilization Method	Application Time
NaOCl at dilutions of 5%, 0.5%, and 0.05%, at pH 7 and pH 12 for each dilution	30 minutes
Ethylene oxide	6 hours
Autoclaving	15 minutes
Glutaraldehyde (2%), pH 8	30 minutes
Boiling	10 and 30 minutes
H_2O_2 (3%)	6 hours
UV (254-nm) irradiation	12 and 24 hours
Free chlorine (1,000 and 10,000 mg/L)	1 hour

RESULTS OF STERILIZATION VIA H_2O_2 AND UV IRRADIATION

	Colony Count (CFU/mL) (% Effectiveness)			
	H_2O_2 (3%)	12-Hour UV Irradiation	24-Hour UV Irradiation	Control
Tile	0 (100)	32 (80.2)	18 (88.9)	162
Fabric clothing	0 (100)	0 (100)	0 (100)	143
Wood	0 (100)	16 (89.1)	0 (100)	148
Protective suit	0 (100)	14 (90.3)	0 (100)	145
Glass	0 (100)	28 (82.3)	21 (86.7)	158
Paper	0 (100)	12 (92.2)	0 (100)	154
Soil	7 (95.8)	78 (52.7)	50 (69.7)	165
Distilled water	0 (100)	10 (92.8)	6 (95.7)	138
Plastic	0 (100)	12 (92.8)	7 (95.4)	152
Metal	0 (100)	23 (85.4)	11 (92.9)	157

Does PXUV has an effect on Coronavirus?



A new (novel) coronavirus has been identified in Wuhan City, China. It has been named 2019-nCoV, or, colloquially, Wuhan Coronavirus. Coronavirus is a large family of zoonotic viruses, meaning they transmit easily from animals to humans, and range from flu-like diseases to deadly respiratory diseases. We have all been exposed to some type of coronavirus before, however some strains pose greater health concerns than others. Wuhan coronavirus, like its viral cousins Severe Acute Respiratory Syndrome (SARS) coronavirus and Middle Eastern Respiratory Syndrome (MERS) coronavirus, presents the potential for widespread epidemic

Does PXUV has an effect on Coronavirus?

Table 1: Independent laboratory testing results, involving pulsed xenon ultraviolet

Organism	Cycle time (minutes)	Distance (metres)	Pathogen count before disinfection	Pathogen count after disinfection	Logarithmic reduction measured
Klebsiella pneumoniae	5	1	1.88E+10	3.42E+01	8.74
Pseudomonas aeruginosa	5	1	9.12E+10	4.30E+01	9.33
Acinetobacter baumannii	5	1	6.07E+10	4.67E+01	9.11
Escherichia coli	5	1	3.32E+10	2.68E+01	9.09
Staphylococcus aureus	5	1	4.52E+10	3.47E+01	9.11
Geobacillus stearothermophilus	5	1	1.69E+06	2.57E+02	3.82
Bacillus atrophaeus	5	1	4.89E+05	2.51E+02	3.29
Aspergillus niger	5	1	1.07E+03	5.02E+02	0.33
Aspergillus niger	10	1	1.07E+03	1.37E+02	0.89
Aspergillus niger	15	1	1.07E+03	6.03E+01	1.25
Aspergillus niger	30	1	1.07E+03	4.10E+01	1.61
MERS-CoV (liquid)	5	1	4.13E+04	2.17E+04	1.54
Vaccinia virus (liquid)	5	1	4.98E+06	1.63E+05	1.38
IBDV (liquid)	5	1	2.41E+07	3.33E+06	0.86
VSV (dried)	5	1	2.60E+05	0.00E+00	All
Bacillus anthracis	15	1	4.5E+03	0.00E+00	All
Ebola virus	1	1	1.85E+07	0.00E+00	All

IBDV: infectious bursal disease virus, MERS-CoV: Middle East respiratory syndrome coronavirus, VSV: vesicular stomatitis virus

LightStrike™ gets stamp of approval for COVID-19 Elimination

LightStrike™ pulsed xenon disinfection robot is the first and only ultraviolet (UV) disinfection technology proven to deactivate the actual SARS-CoV-2 in two minutes. Testing was performed at the Texas Biomedical Research Institute, one of the world's leading independent research institutes working exclusively on infectious diseases.

Xenex validated the efficacy of their robot against live (not surrogate) SARS-CoV-2 in the biosafety level 4 (BSL-4) containment laboratory at Texas Biomedical Research Institute. Testing was also performed to measure decontamination of N95 respirator masks, as a result of healthcare facilities being forced to reuse personal protective equipment (PPE), and the robot achieved a 99.99% level of disinfection.

Designed for maximum containment, BSL-4 labs offer a safe environment for scientists to study deadly pathogens for which there are no known treatments or vaccines. Texas Biomed is home to one of fewer than 10 BSL-4 labs in North America and the only privately owned one. The Institute has both the expertise and resources to test against these pathogens. In 2015, also at Texas Biomed, Xenex proved the ability of the LightStrike robot to destroy the Ebola virus in 1 minute.

XENEX®
DISINFECTION SYSTEMS™

XENEX® LIGHTSTRIKE™

GERM-ZAPPING **ROBOTS**™

The LightStrike™ Robot

Pulsed Xenon Light

Patented technology using Xenon to create intense broad spectrum light for fast effective disinfection.

Customizable

Create custom selections such as units, room types, room numbers and positions for users to select from.

Sensor Motion Detection

Triple Sensor Motion Detection cone can sense motion from across the room.

Cloud-Based Reporting

Comprehensive real-time reporting to Xenex's secure, cloud-based Portal using WIFI or cellular data.

Additional Product features:

- Fast, 5-minute cycle times
- Environmentally friendly
- Recessed bulb for easy, safe transport

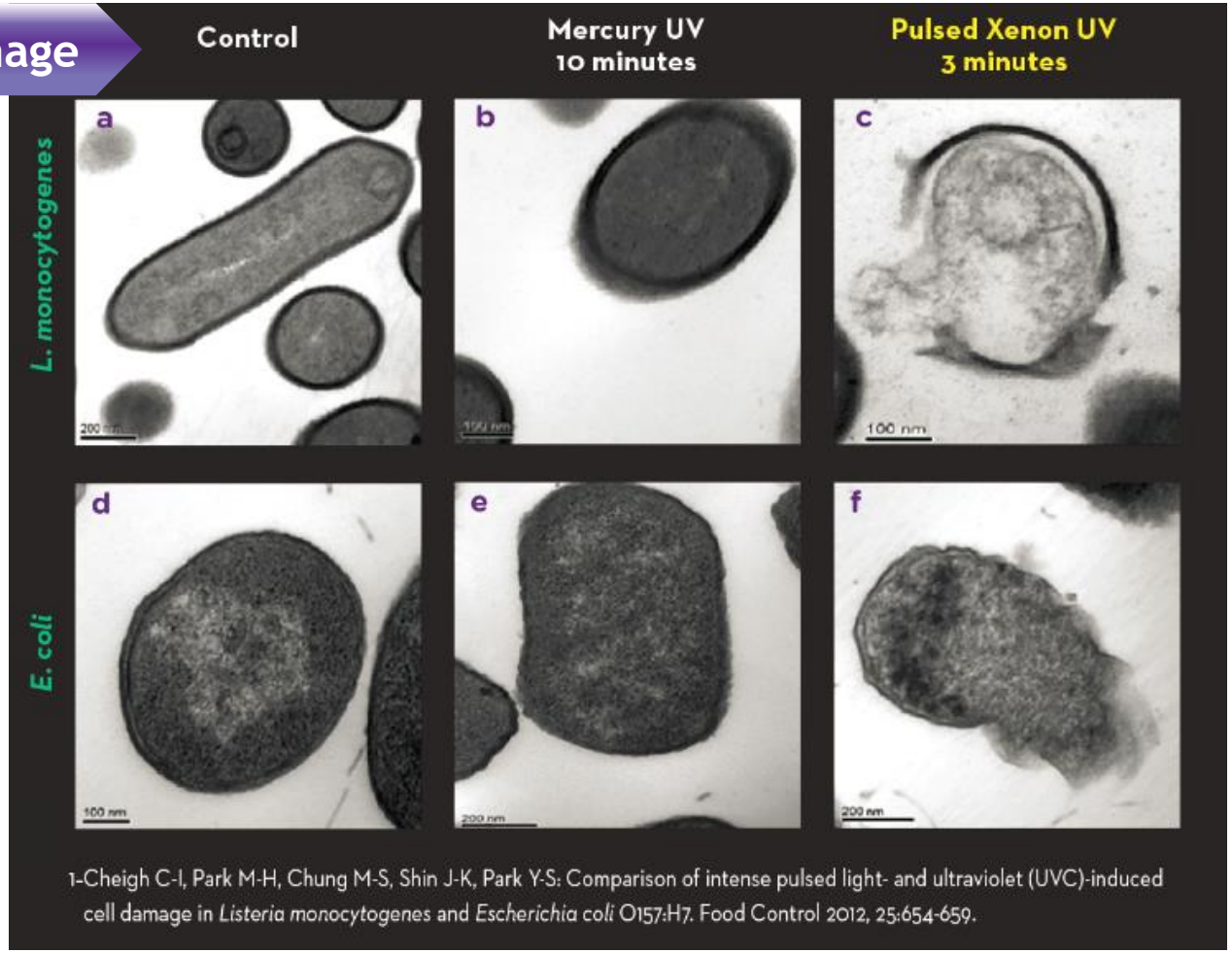
Impact-Resistant Hardware

Hardware designed for ease of use and extreme durability and reliability.

XENEX® DISINFECTION SYSTEMS™

Why Intensity & Broad Spectrum Matter

Comparative Cell Damage

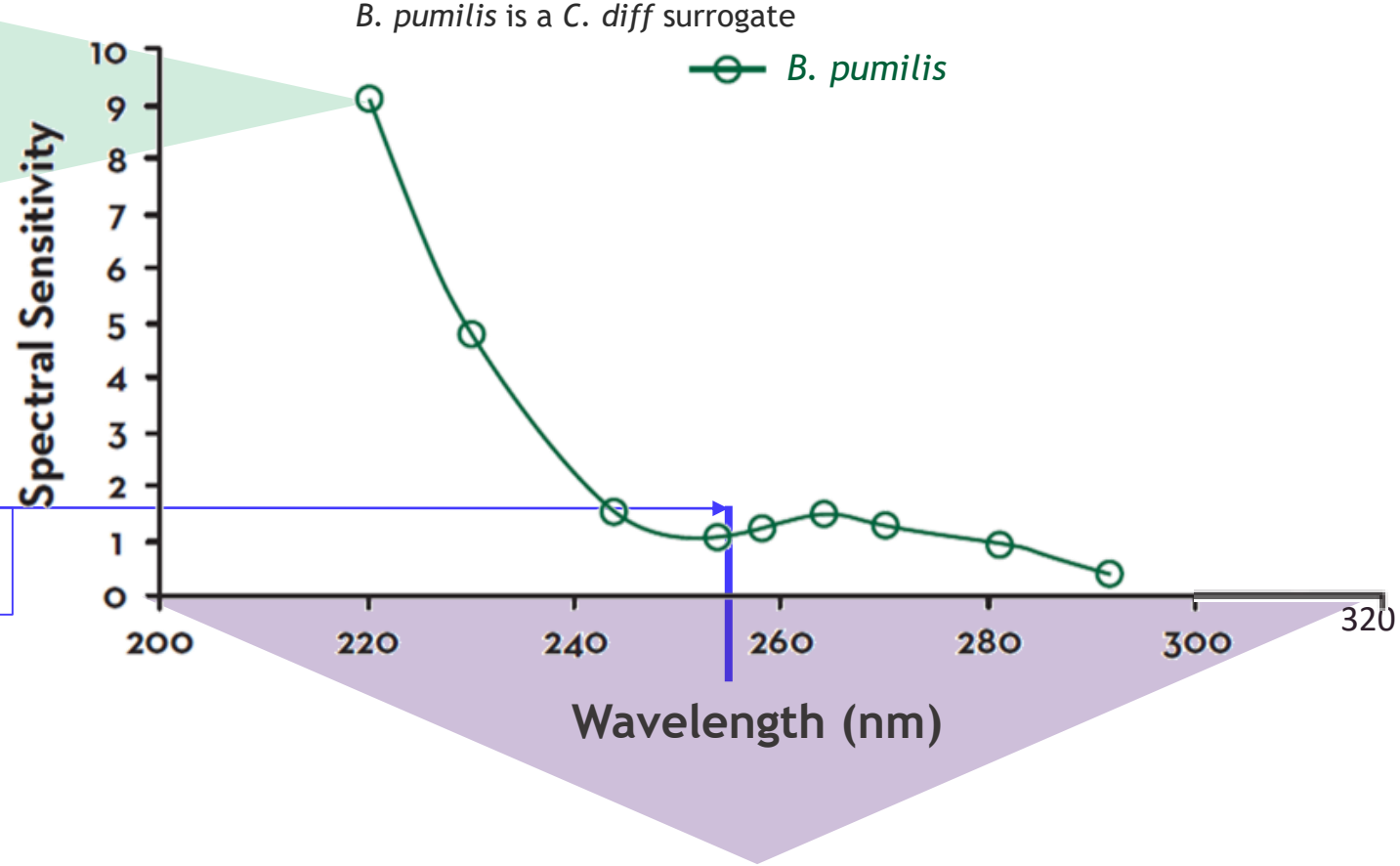


1-Cheigh C-I, Park M-H, Chung M-S, Shin J-K, Park Y-S: Comparison of intense pulsed light- and ultraviolet (UVC)-induced cell damage in *Listeria monocytogenes* and *Escherichia coli* O157:H7. Food Control 2012, 25:654-659.

Pulsed Xenon light can cause physical cell damage and lysing because of the broad spectrum UV emitted.

Why Intensity & Broad Spectrum Matter

The Most Effective Wavelength to Deactivate *B. pumilis* is 220-240 nm



Mercury UV Produces Narrow Spectrum Light at 253.7 nm

Intensity Matters!

In a comparison lab test of our Pulsed Xenon bulb and a Mercury bulb, our Pulsed Xenon bulb performed at 4300 X more intensity than the Mercury bulb.*

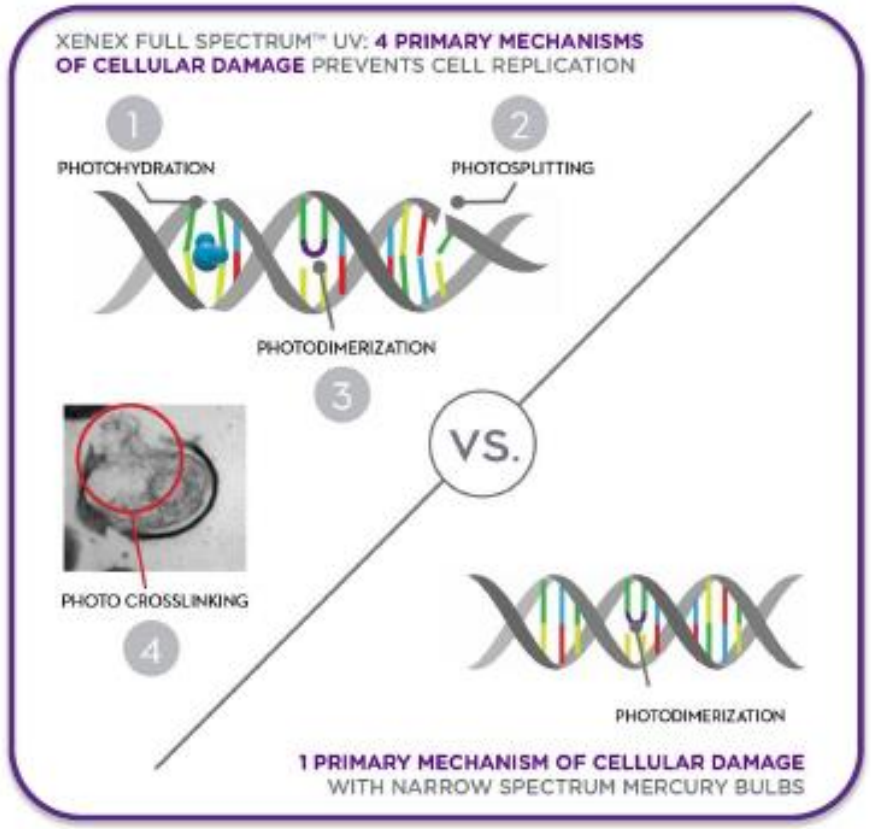
Xenex Produces Light From 200-315 nm

Adapted from: 2015 Beck et al. Water research, ISSN: 1879-2448, Vol: 70, Page: 27-37

* Lab testing conducted on a Philips RUV325HO bulb

Mechanism Of Disinfection By UVC

UV-C directly attack DNA/RNA of micro organism



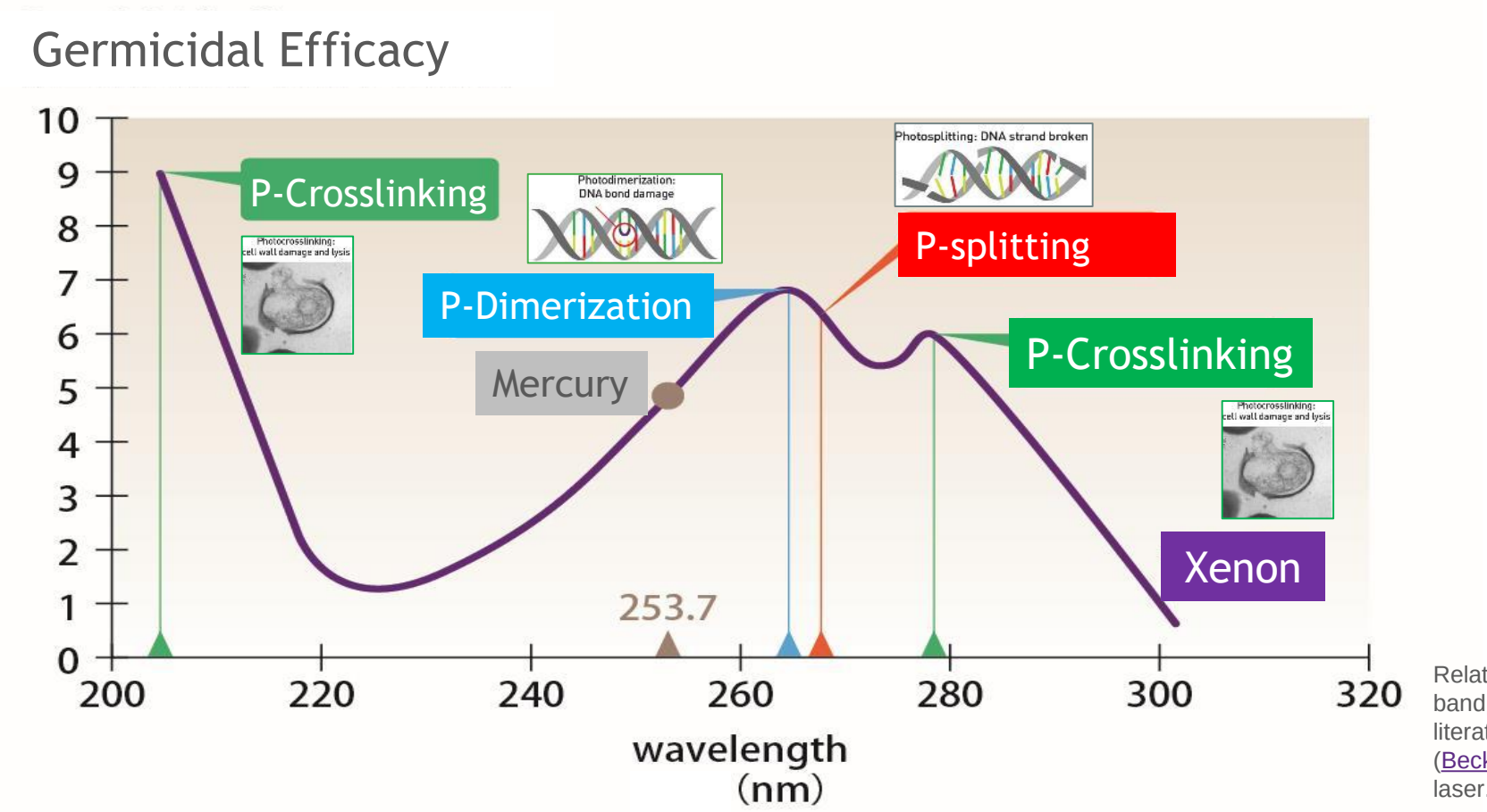
1. Photo-hydration
2. Photo-splitting
3. Photo-dimerization
4. Photo-crosslinking

- Xenon broad spectrum UVC can occur all mechanisms
- Mercury can occur only #3

Micro organism (include MDRO) cannot get resistance to UV-C

Difference Between Xenon and Mercury

1. Wave Length Xenon generate 200nm-315nm, Mercury generate only 253.7nm

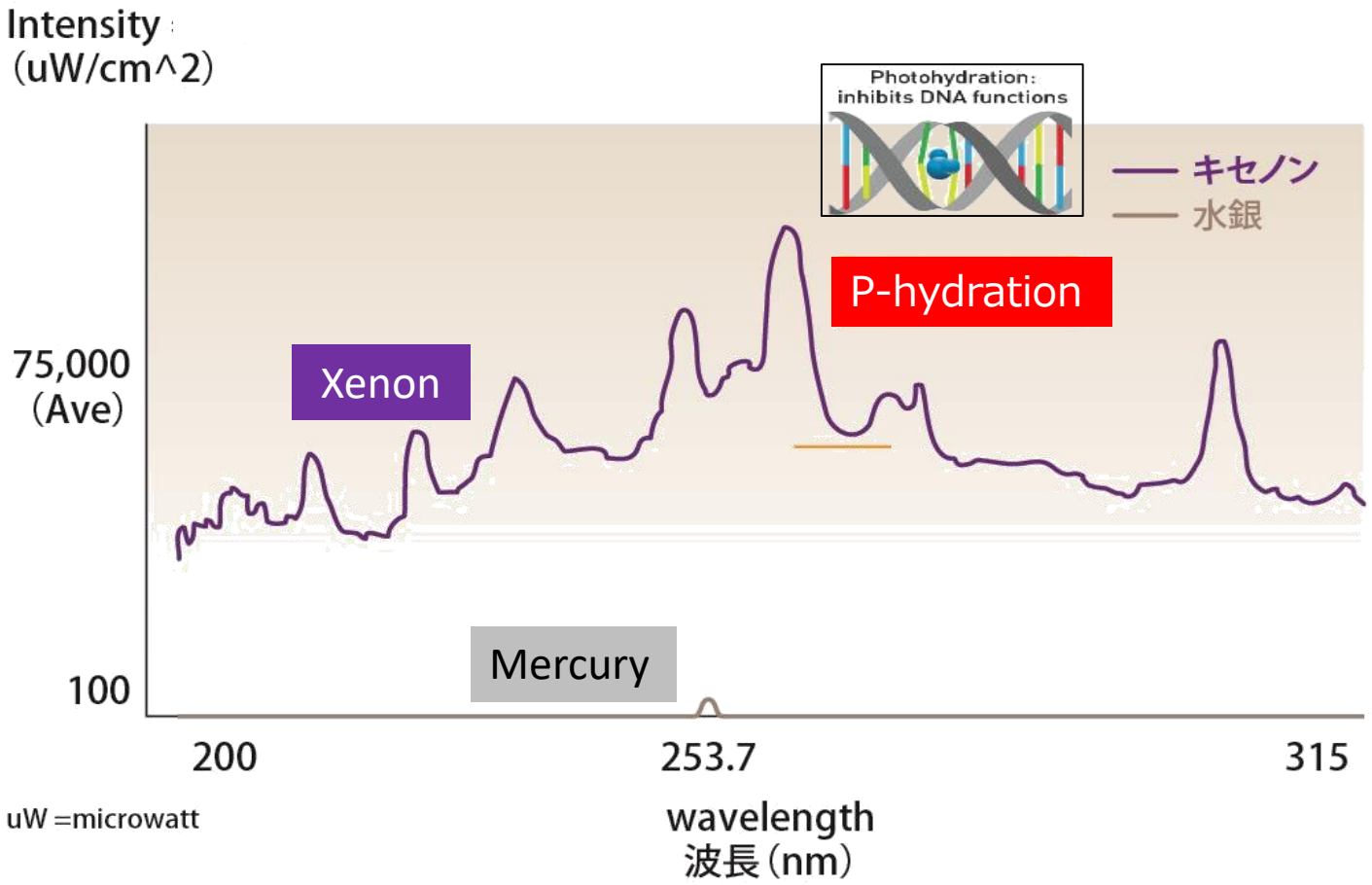


XENEX LIGHTSTRIKE™ GERM-ZAPPING ROBOTS™

Relative spectral sensitivity of *Bacillus pumilus* to MP UV light with bandpass filters as compared with a *B. pumilus* spectrum from the literature (Rochelle et al., 2010) and the MS2 and adenovirus 2 (Beck et al., 2014) spectral sensitivity to UV light from the tunable laser.

Difference Between Xenon and Mercury

2.Intensity By using pulse method, LIGHTSTRIKE can irradiate 750times higher intensity than low intensity mercury



XENEX LIGHTSTRIKE™ GERM-ZAPPING ROBOTS™

Reference : (L) Zuzana Bohrerova : Comparative disinfection efficiency of pulsed and continuous-wave UV irradiation technologies WAT ER RE S E ARCH 42 (2008) 2975 – 2982

Reference : (R) Chan-Ick Cheigh : Comparison of intense pulsed light- and ultraviolet (UVC)-induced cell damage in Listeria monocytogenes and Escherichia coli O157:H7. Food Control 25(2), 2012, p. 654–659

Disinfecting with LightStrike™ Robots

Patient Rooms

3 positions

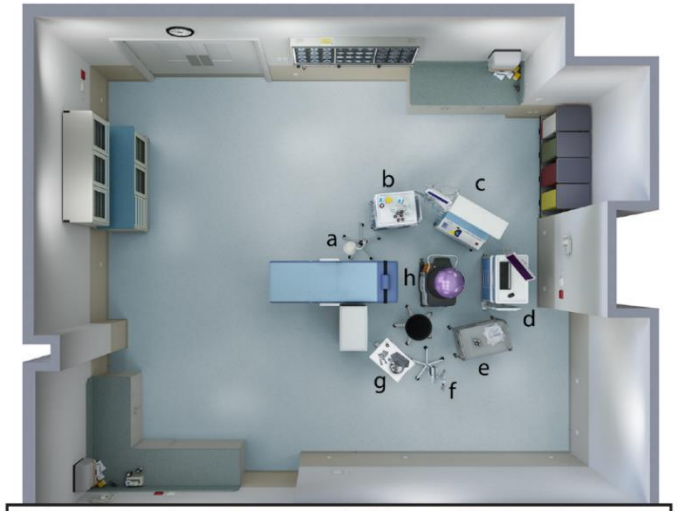
OR - Terminal Clean

2 positions

XENEX® DISINFECTION SYSTEMS™

Disinfecting with LightStrike™ Robots

MD Anderson Cancer Treatment Center published a study in Oct. 2017 in BioMed Central before and after a 2-minute cycle of LightStrike's Pulsed Xenon light, concluding a ***73% decrease*** *in bacterial load when compared to manual cleaning alone.*



Equipment: a-lamp, b-supply cart, c- anesthesiology machine, d-anesthesia cart, e-cart, f-IV pump, g-mayo stand, h-LightStrike robot

1 position

Between-Case Disinfection:

- Goal is to quickly reduce microbial contamination on high-touch surfaces in the immediate surgical area
- Targeting anesthesia station, monitors, medication cart, IV poles, chairs, etc. at the head of the OR table
- Does not replace overnight terminal cleaning or whole room disinfection

Lynn El Haddad, Shashank S. Ghantoji, Mark Stibich, Jason B. Fleming, Cindy Segal, Kathy M. Ware and Roy F. Chemaly (2017). "Evaluation of a pulsed xenon ultraviolet disinfection system to decrease bacterial contamination in operating rooms." BMC Infectious Diseases. 17:672.

Labor Model – Full Time Person Assigned

ICU
Intensive Care Unit

PCU
Progressive Care Unit

MSICU
Medical/Surgical Intensive Care Unit

CCU
Coronary Care Unit

Med-Surg
Medical-Surgical

Women's
OB/L&D/GYN

1 Robot, 1 Full Time User
1 Shift of 8 hours =
3 patient rooms/hr x 7 hrs=
Up to 21 discharges per day

Labor Model - Shared Operator

ICU
Intensive Care Unit

PCU
Progressive Care Unit

MSICU
Medical/Surgical Intensive Care Unit

CCU
Coronary Care Unit

Med-Surg
Medical-Surgical

OR
Operating Room
- AFTER 10pm

Women's
OB/L&D/GYN

1 Robot, Shared Users
2 Shifts of 8 hours =
3 patient rooms/hr x 14 hrs =
Up to 42 discharges per day

Time Efficiencies

VENDOR	SPORICIDAL CYCLE MINUTES	NUMBER OF POSITIONS	CYCLE TIME VARIES	MOVEMENT/ REPOSITION TIME	WARM-UP/ COOL DOWN MINUTES	DISCHARGES/ YEAR	C. diff OUTCOMES
Xenex	5	3	No	7	0	4,964	70%
Mercury Product A	8	3	Yes	7	11	2,600	0%
Mercury Product B	52	1	Yes	3	11	1,655	0%
Mercury Product C	47	1	Yes	3	11	1,820	N/A
Hydrogen Peroxide Vapor	120	1	No	Unknown	Unknown	910	52%

Nagaraja, et al (2015) American Journal of Infection Control; MCcord, et.al (2016) Journal of Hospital Infection; Pegues et. al., (2017) Infection Control and Hospital Epidemiology; Anderson et. al., (2017) Lancet

Peer Reviewed HAI Rate Reduction Studies

70% reduction in ICU *C. diff* rates

Westchester Medical Ctr, AJIC 2015

87% reduction in ICU VRE rates

South Seminole-ORMC, AJIC 2015

100% reduction in total joint SSIs

Trinity Medical Center, AJIC 2015

57% reduction in LTAC *C. diff* rates

S.E. US LTAC, AJIC 2015

39% reduction in *C. diff* rates

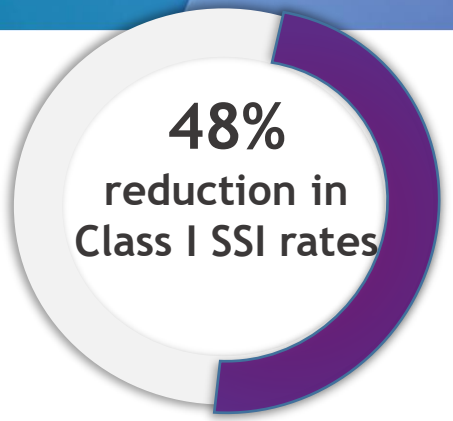
Mayo Clinic, AJIC 2018 – In Press

71% reduction in UTI rates

Jewish Home & Care, BMC Inf Dis 2017

XENEX® DISINFECTION SYSTEMS™

Peer Reviewed HAI Rate Reduction Studies

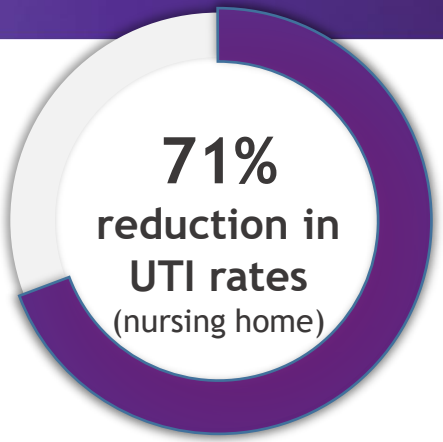


Lowell General Hospital,
AJIC 2016

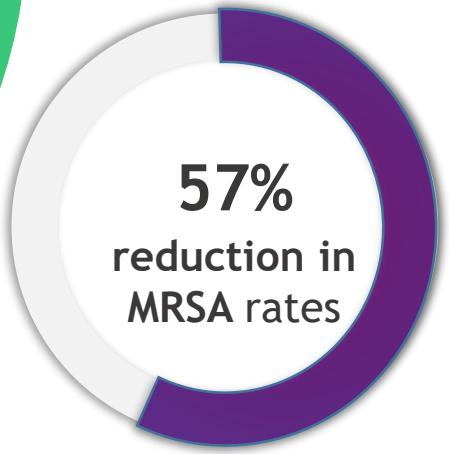
Trinity Medical Center, AJIC 2015

24

PUBLISHED,
PEER REVIEWED
STUDIES



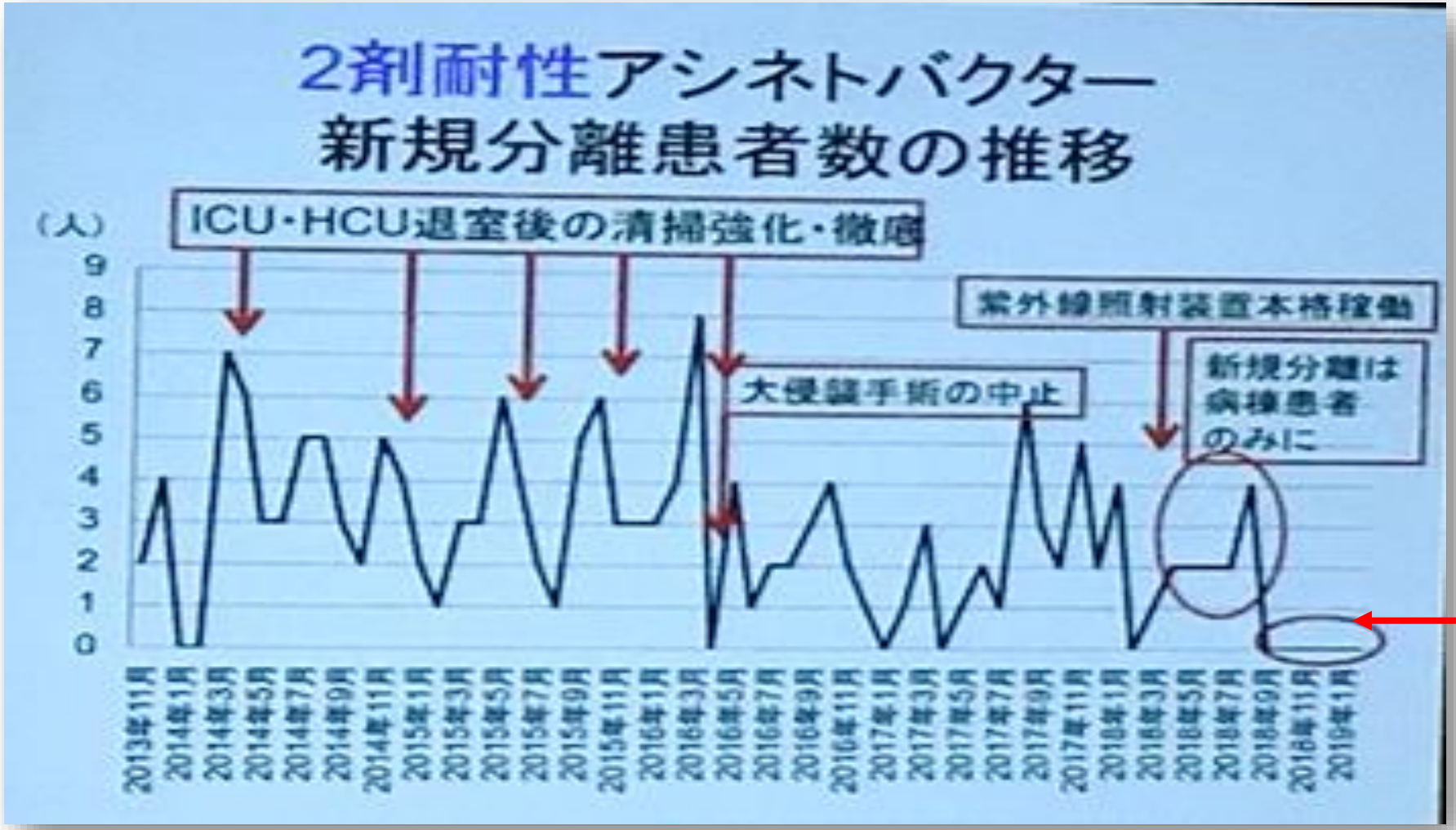
Jewish Home & Care,
BMC Inf Dis 2017



Cone Health System, JIP 2013

XENEX® DISINFECTION SYSTEMS™

Trend of Infection Rate in Yamagata University Hospital



Implemented Pulsed Xenon UV, Xenex LightSrike™

Evidence Outline of Yamagata University Hospital

- Reason of installation：Suppress the proliferation of MDRA (multi-drug resistant *Acinetobacter*)
- Progress result：After installing the device, bacteria segregation rate is reduced by half; after 7 months of continuous usage, segregation rate turns to 「0」

	2015	2016	2017													2018								2019							
	年間	年間	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月	年間	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月	1月	年間	2月	3月
ICU	16	10			2					1		1	2	1	7	2			1	1		1	1							4		
HCU	10	12						1		3	1	2	2	1	10						1	1		1						3		
NICU	0	0													0														0		
一般	2	1													0														0		
病棟	0	0													0														0		
	0	0													0														0		
	0	1													0														0		
	0	0													0								1						1		
	1	0					1	1		1		1	1		5								1						1		
	2	7							1		1				2				1	1									2		
	0	0													0							1							1		
	6	1		1	1										2	2							1						1		
	0	0													0														0		
	1	1						1			1				2														0		
	0	0													0														0		
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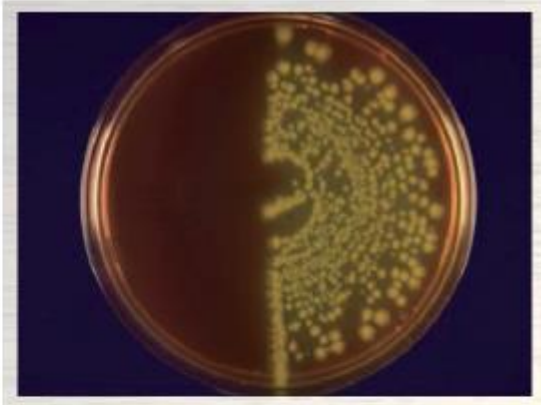
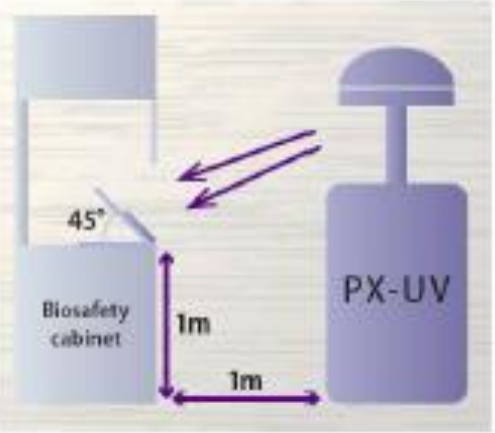
	1	0								1					1														0		
計	39	33	0	1	3	0	1	3	1	6	3	4	5	2	29	4	0	1	2	2	2	2	4	0	0	0	0	0	13	0	0

Disinfection Lab test

CRE (*E. coli*, *Klebsiella*属)



Clostridioides difficile



MDRA (多剤耐性アシネトバクター)

MRSA (メチシリン耐性黄色ブドウ球菌)

Test conditions
Apply select target medium to each selective medium by using automatic sample quantification plater.
After covering right half side with aluminum, irradiate PX-UV 5 minutes. After irradiation 24-48 hours in incubator (37 ℃) culture was performed.

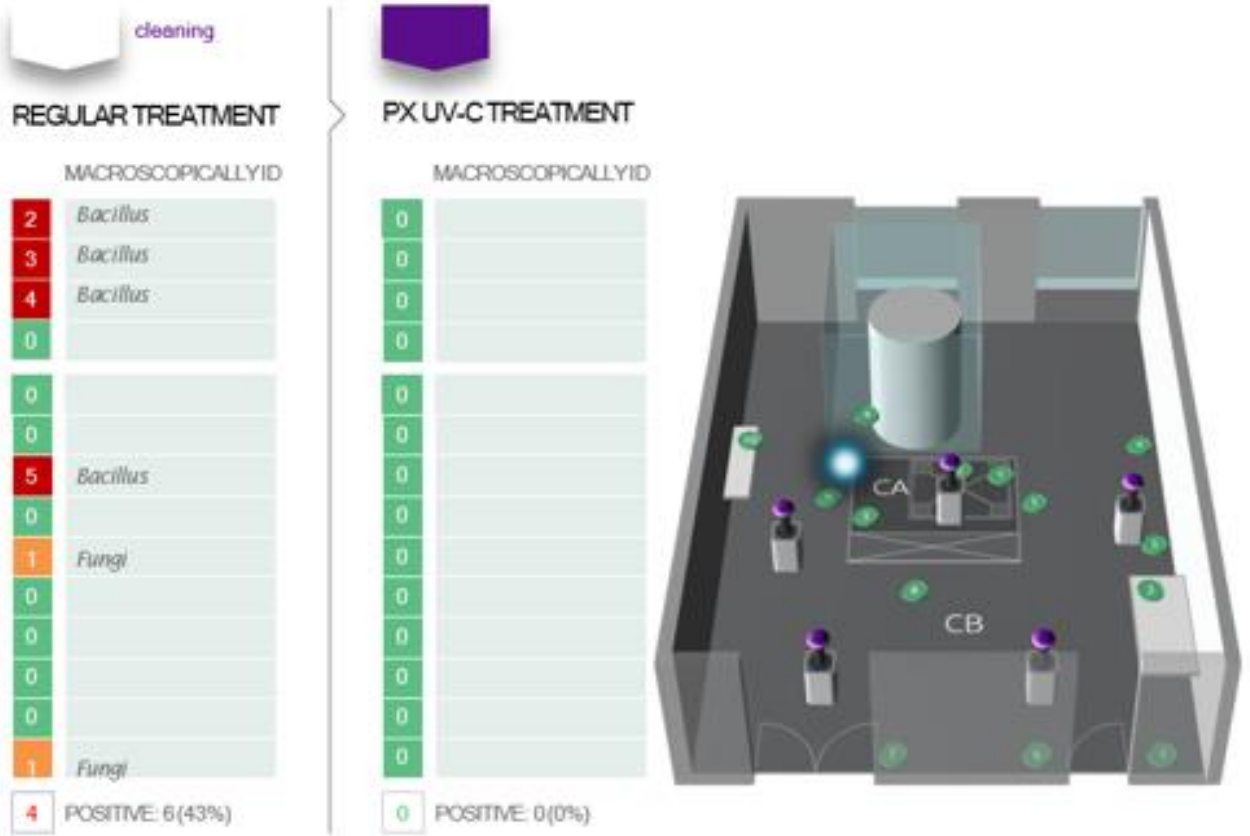
XENEX® DISINFECTION SYSTEMS™

LightStrike's Intensity to Disinfect the Cleanroom Environment

Cleanroom Efficacy - Regular Treatment

A leading pharmaceutical company using LightStrike Robots to disinfect their Class A/B cleanrooms after a production day with Bacillus contamination

- The first column shows bacterial load on surfaces after the standard regular (manual) cleaning
- The second shows the bacterial load on surfaces after using the LightStrike Robots in conjunction with the standard Class A/B Cleaning Protocol



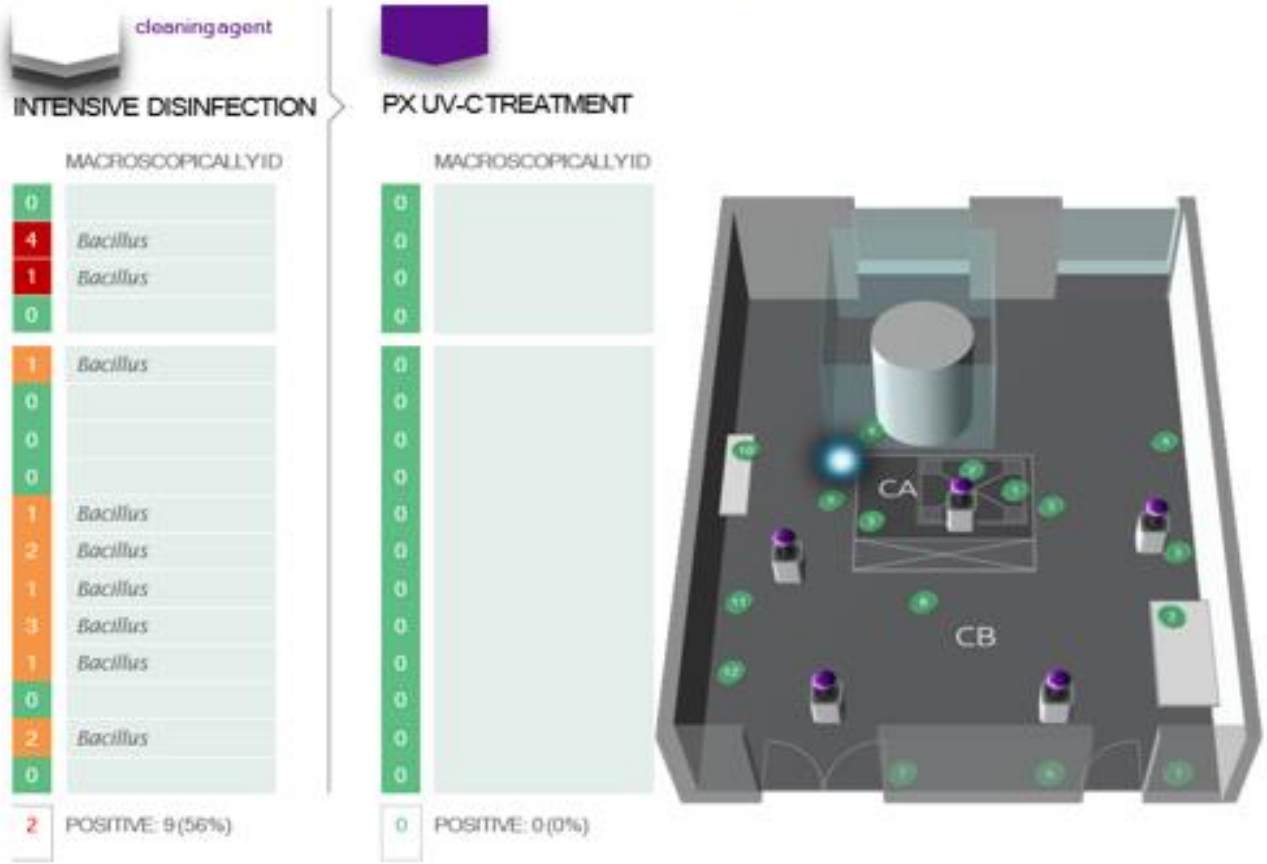
Xenex and the LightStrike technology do not make any claims against air disinfection or particulate counts in the air of the Cleanroom environment

XENEX® DISINFECTION SYSTEMS™

Cleanroom Efficacy - Intensive Disinfection

The same leading pharmaceutical company integrated an intensive disinfection process prior to use of the LightStrike Robots to disinfect their Class A/B cleanrooms after a production day with Bacillus contamination

- The first column shows bacterial load on surfaces after an intensive disinfection (manual) process
- The second shows the bacterial load on surfaces after using the LightStrike Robots in conjunction with the Intensive Disinfection process
- The Intensive Disinfection process is a 3 step process that utilizes a sporicidal agent after each of 3 consecutive cleanings



Xenex and the LightStrike technology do not make any claims against air disinfection or particulate counts in the air of the Cleanroom environment

XENEX DISINFECTION SYSTEMS™

The Xenex Partnership

A Successful HAI Rate Reduction Program Includes:

- Conducting a full data analysis
- Establishing goals & objectives
- Building a customized LightStrike™ Deployment Strategy
- Providing on-going training and support
- Optimizing workflow and integration

We are with you every step of the way to ensure a seamless integration of your Xenex Program.

Program Xe easily integrates into your hospital operations.

The Xenex Partnership

Program Validation

- Scheduled program reviews
- Metrics & reporting
- Program outcomes/ROI progress benchmark
- Opportunities for program enhancement

Access to a Team of Experts

- Infection Preventionists
- Epidemiologists
- Environmental Services
- Health Care Data Analysts

The commitment from Xenex doesn't stop here. Your dedicated team of Infection Rate Reduction Specialists will schedule regular check-ins by phone and in-person.

Deploying Your New Standard of Care

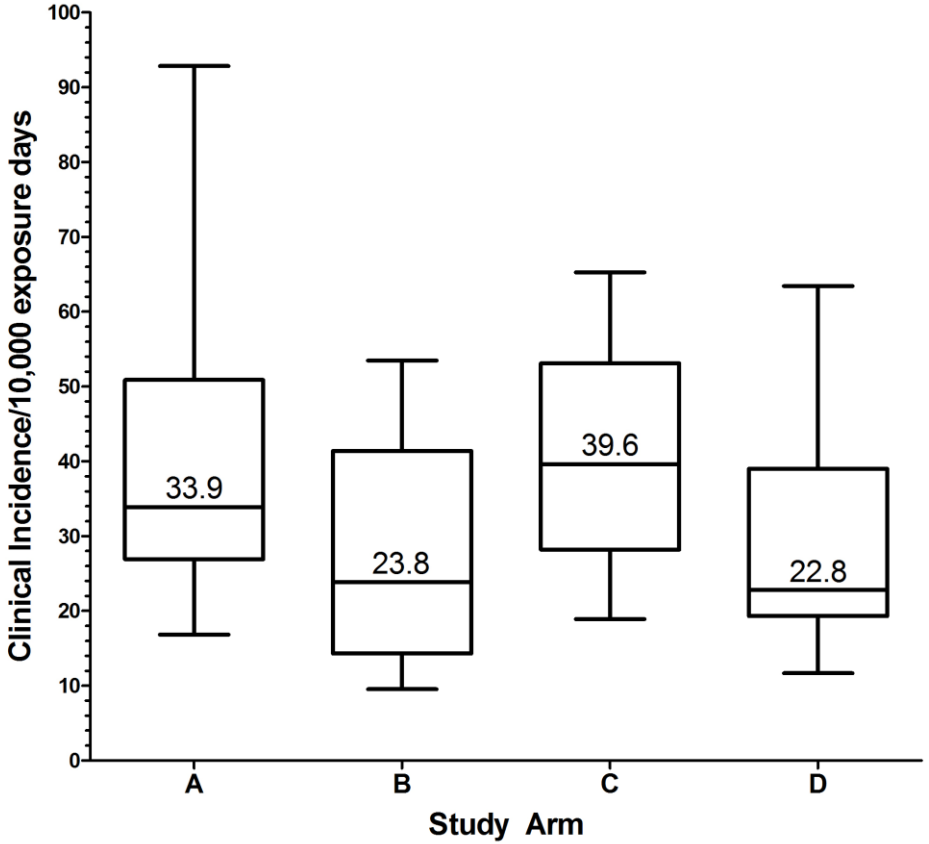
Environment CFU

MD Anderson Cancer Treatment Center conducted a study to measure colony forming units before housekeeping, after housekeeping and after disinfecting with Xenex Robots.

Room Status	Observations	HPC Mean (CFU/inch^2)	Confirmed VRE
Pre-Clean	75	213.7	17 (23%)
Post-Housekeeping	49	178.5	4 (8%)
Post-Xenex	75	7.8	0

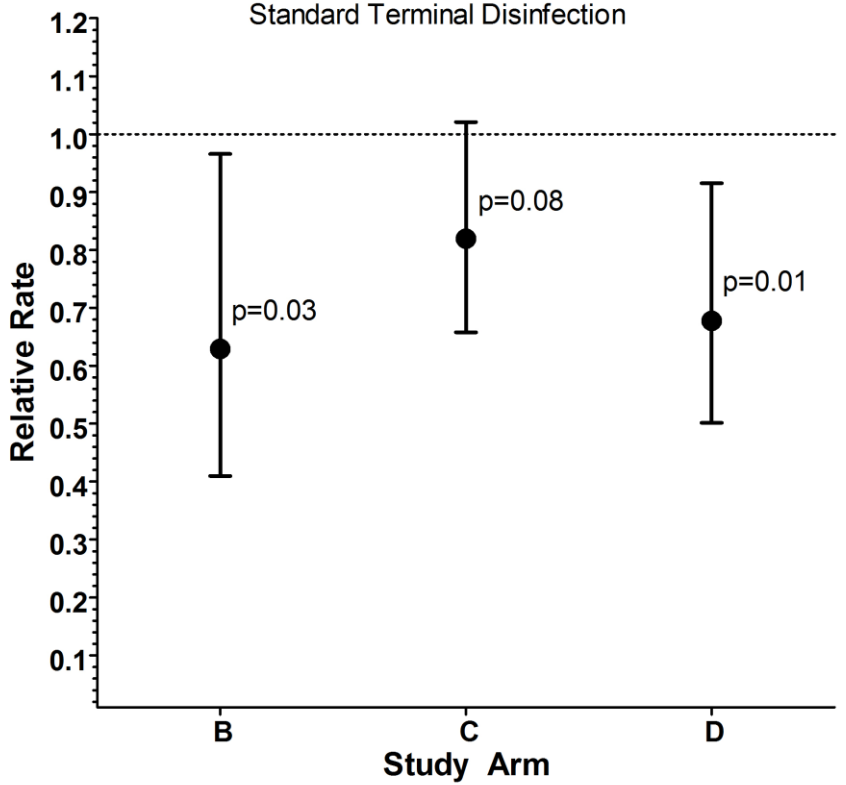
The Benefits of Enhanced Terminal Room (BETR) Disinfection Study: A Cluster Randomized, Multicenter Crossover Study with 2x2 Factorial Design to Evaluate the Impact of Enhanced Terminal Room Disinfection on Acquisition and Infection Caused by Multidrug-Resistant Organisms (MDRO)

Figure 2. ITT Analysis - Clinical Incidence of All Target MDROs following 4 Terminal Room Disinfection Strategies in 9 Hospitals



Study Arm Description: A-quaternary ammomium (reference); B-quaternary ammonium+UV-C emitter; C-bleach; D-bleach+UV-C emitter

Figure 3. ITT Analysis - Relative Clinical Incidence of All Target MDROs following Enhanced Terminal Room Disinfection Strategies* in 9 Hospitals Compared to Standard Terminal Disinfection



*Study Arms B (quaternary ammonium+UV-C emitter), C (bleach), and D (bleach+UV-C emitter) were compared to Study Arm A (quaternary ammomium). Model controlled for time period, hospital, and correlation between different study phases within the same hospital

Conclusion: Enhanced terminal room disinfection strategies that utilized UV-C emitters reduced the risk of acquisition and infection caused by target MDRO

MAYO CLINIC
HEALTH SYSTEM

C. diff CONTROLLED STUDY IN 6 ICUs

39% decrease
in CDI incidence on
Xenex Units (p=0.03)

30% increase
in CDI in **control units** (non-Xenex)

20% drop
in **CDI SIR Score**

THE STANDARD OF CARE
XENEX
IN OVER 400 HOSPITALS

XENEX is now the Standard of Care

XENEX DISINFECTION SYSTEMS™

MAYO CLINIC
HEALTH SYSTEM

VRE CONTROLLED STUDY IN 6 ICUs

62% decrease
in CDI incidence on
Xenex Units (p=0.016)

3% increase
in VRE in **control units**

THE STANDARD OF CARE
XENEX
IN OVER 400 HOSPITALS

XENEX is now the **Standard of Care**

XENEX DISINFECTION SYSTEMS™

MAYO CLINIC
HEALTH SYSTEM

Patient Satisfaction for Cleanliness of the Environment Increased

From 70 to 77%

THE STANDARD OF CARE
XENEX
IN OVER 400 HOSPITALS

XENEX is now the **Standard of Care**

XENEX DISINFECTION SYSTEMS™

Over 400+ Hospitals Using LightStrike

XENEX® DISINFECTION SYSTEMS™

Healthcare Visionaries

We switched from mercury UV to Xenex LightStrike Robots and saw a 25% rate reduction.

After reviewing the evidence, we implemented a Xenex LightStrike program and reduced C. diff rates by 100%.

Visionaries are experienced leaders in their field who've embraced new solutions, such as the Xenex program to further their commitment to excellence in patient safety.

After implementing our Xenex LightStrike program, we reduced HAI rates facility wide by 76% and saved an estimated $1.23 Million.

We added Xenex LightStrike Robots to our disinfection process and achieved a 70% HAI rate reduction and cost savings of $750K.

Rush Foundation Hospital Reports Fewer Infections after Adding LightStrike Pulsed Xenon UV Disinfection as Environmental Standard of Care

As germs and bacteria become increasingly resistant to cleaning chemicals, antibiotics and even some hand sanitizers, the hospital is continually on the lookout for new technologies to aid in its infection prevention efforts. With the rise of superbugs such as C.diff, MRSA and Vancomycin-resistant enterococci (VRE), healthcare facilities like Rush Foundation Hospital are turning to LightStrike robots to destroy dangerous pathogens before they can pose a risk to patients and hospital employees. Using high intensity pulsed xenon ultraviolet (UV) light, the robots quickly destroy microscopic pathogens that can cause infections.

"Every time someone comes in to this facility they are bringing in contamination from the outside. Adding the LightStrike Germ-Zapping Robots to our thorough cleaning protocol is an additional measure we took to enhance patient safety. We made this investment as a commitment to the community we serve, and we are extremely pleased with the results we have achieved."

Jason Payne, Administrator of Rush Foundation Hospital

Xenex LightStrike™ Germ-Zapping Robot deactivates SARS-CoV-2 in Singapore

One of Singapore's leading general hospitals has deployed the Xenex LightStrike Germ-Zapping Robot, proven to destroy live (not surrogate) SARS-CoV-2.

Xenex LightStrike Germ-Zapping Robot can deliver up to 4,300 times more germicidal UV pathogen killing intensity than mercury UV technologies and can disinfect an entire patient room in as little as three 5-minute cycles.

The LightStrike robot plays an instrumental role in complementing the thorough cleaning work carried out by the hospital team. After the usual cleaning protocol, which includes manual cleaning and disinfection, the cleaning personnel will deploy the LightStrike robot into a room and effectively disinfect the room in just a few minutes.

https://www.biospectrumasia.com/news/91/16026/xenex-lightstrike-germ-zapping-robots-deactivate-sars-cov-2-.html

Awarded Most Mindshare for UV Disinfection

KLAS Research, an independent 3rd party analyst firm, recently conducted a survey of hospitals about infection prevention technologies. KLAS identified Xenex as having the most (and the most positive) mindshare (for UV disinfection) among the hospitals polled.

The reasons Xenex topped their list are:

- ROI (infection rate reductions)
- Reporting and measured outcomes
- Workflow/ease of use
- Vendor support and guidance
- Access to portal data

KLAS®
ACCURATE HONEST IMPARTIAL

Xenex was also the only UV company polled whose clients were looking to purchase more Robots to expand their use of the Xenex program into other areas of the hospital.

Infection Control 2019, An Early Look At Innovative Technologies

Xenex Receives Top Honors from Frost & Sullivan for LightStrike™ The Only Pulsed Xenon UV Disinfection System in the Healthcare

ww2.frost.com/news/press-releases/xenex-receives-top-honors-frost-sullivan-lightstrike-only-pulsed-xenon-uv-disinfection-system-healthcare-market/

Contact Frost Store Partner login

FROST & SULLIVAN
The Growth Pipeline™ Company

INDUSTRY SOLUTIONS INSIGHTS ABOUT

SANTA CLARA, Calif. — May 24, 2017— Based on its recent analysis of the healthcare room disinfection industry, Frost & Sullivan recognizes Xenex Disinfection Services with the 2017 Global Frost & Sullivan Award for Visionary Innovation Leadership. The Xenex LightStrike™ Germ-Zapping Robot™ is a differentiated, portable, no-touch device capable of helping healthcare facilities bring down infection rates by destroying the pathogens that cause them. LightStrike robots deactivate microorganisms, including *Clostridium difficile (C. diff.)*, rapidly and cost effectively to reduce the risk of hospital-acquired infections (HAIs).

"While most companies in the hospital disinfection space offer single-spectrum mercury ultraviolet (UV) systems or hydrogen peroxide-based disinfection systems, Xenex's UV disinfection system sets itself apart via its use of xenon, an environmentally-friendly inert gas, to create UV-C light," said Frost & Sullivan Industry Analyst Brahadeesh Chandrasekaran. "Pulsed xenon UV light is significantly more intense than mercury UV systems and covers the entire germicidal spectrum. And while some Xenex customers report disinfecting dozens of rooms per day with a single device, we were most impressed with the hospitals that have reported 50-100% reductions in their infection rates after using the LightStrike robots to disinfect their facilities."

Xenex LightStrike robots are the only UV technology to be credited by hospitals in multiple peer reviewed and published outcome studies for their role in helping the hospitals reduce infection rates. Xenex devices stand head and shoulders above room disinfection alternatives with their quick, simple disinfection, proven infection reduction results, and have been in use for more than five years with no reported materials damage. Xenex has transformed the traditional way of disinfecting healthcare facilities through its innovative and visionary product and service offerings.

basis. Read @_ananyaaa's story on @qzindia here: bit.ly/3ckVvJH

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Cellwize Lauded by Frost & Sullivan for its Cloud-based, AI open RAN automation platform, Chime

Frost & Sullivan Analyzes the Evolution of 3rd, 4th and 5th Dimensions of Travel

Waters Corporation earns New Product Innovation Award with first SmartMS-enabled biopharmaceutical solution

FROST & SULLIVAN

2017 BEST PRACTICES AWARD

GLOBAL HEALTHCARE ROOM DISINFECTION VISIONARY INNOVATION LEADERSHIP AWARD

ESP Award Winners: Infection Control Category

First Place: Xenex's Germ-Zapping Robots

Numerous studies have shown that standard cleaning practices leave contamination on OR surfaces that can contribute to Surgical Site Infections. Xenex's pulsed xenon ultraviolet (UV) light disinfection technology quickly destroys the viruses, bacteria and spores, including C.diff, that cause SSIs. A peer-reviewed study currently in press demonstrates how a hospital achieved a 100 percent decrease in SSIs after it began using Xenex for terminal cleans of its ORs. While that facility uses the Xenex robot on terminal cleans at night, other ORs utilize the Xenex robot before total joint cases and/or after dirty cases, reporting a return on investment as a result of fewer infections.

The Xenex Germ-Zapping Robot™ is the only UV disinfection technology that has been shown, in multiple peer-reviewed published studies, to help hospitals reduce HAI rates – with hospitals reporting greater than 50 percent reductions in C.diff, MRSA and SSI rates.

https://www.medicaldesignandoutsourcing.com/esp-award-winners-infection-control-category/

Community Awareness

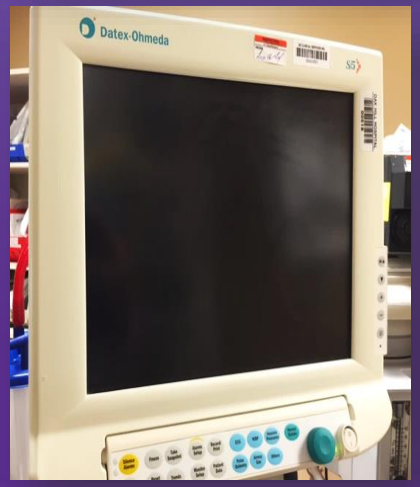
XENEX® DISINFECTION SYSTEMS™

Reported Surface Damage with Mercury UV

Xenex® LightStrike™ Robots have been in hospitals for 6+ years…

There have been no reports or claims related to surface damage or degradation to materials in our client hospitals.

Surface Degradation from Mercury UV



Mercury leads health issues

" WHO endorses using of clean energy source without Mercury containing products i.e. thermometers, barometers, lamps, pharmaceuticals"

World Health Organization

PREVENTING DISEASE THROUGH HEALTHY ENVIRONMENTS

EXPOSURE TO MERCURY: A MAJOR PUBLIC HEALTH CONCERN

Mercury is highly toxic to human health, posing a particular threat to the development of the child *in utero* and early in life. It occurs naturally and exists in various forms: *elemental* (or metallic); *inorganic* (e.g. mercuric chloride); and *organic* (e.g., methyl- and ethylmercury). These forms all have different toxicities and implications for health and for measures to prevent exposure.[1] Elemental mercury is a liquid that vaporizes readily. It can stay for up to a year in the atmosphere, where it can be transported and deposited globally. It ultimately settles in the sediment of lakes, rivers or bays where it is transformed into methylmercury, absorbed by phytoplankton, ingested by zooplankton and fish, and accumulates especially in long-lived predatory species, such as shark and swordfish.[2]

WHO recommendations

National, regional and global actions, both immediate and long-term, are needed to reduce or eliminate releases of mercury and its compounds to the environment. WHO is committed to work with the health sector and national, regional and global health partners to:

- reduce mercury exposure;
- eliminate the use of mercury wherever possible;
- promote the development of alternatives to the use of mercury.

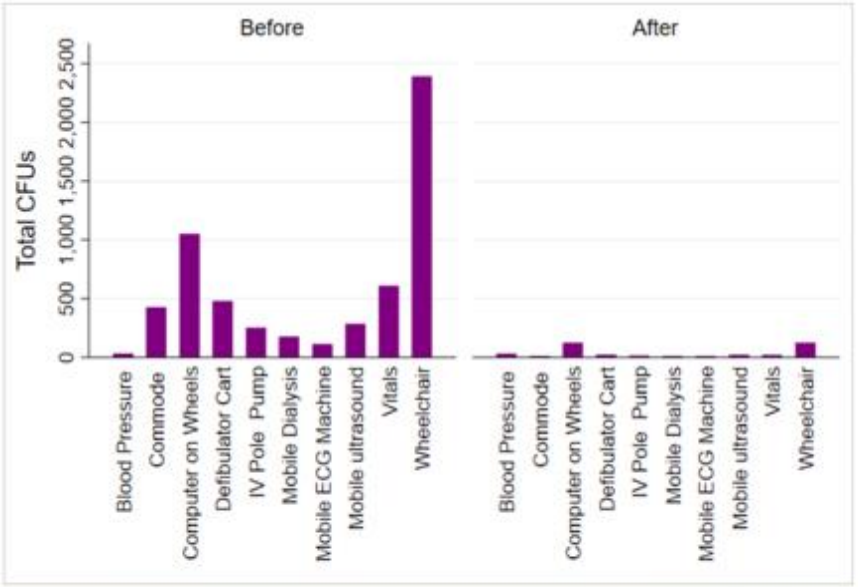
LightStrike Disinfection Pod™

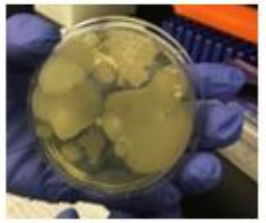
Disinfect Orphan Items Quickly & Easily

- First of its kind mobile equipment disinfection pod
- Lightweight, collapsible mobile unit that sets up in minutes
- Disinfect items such as Isolates, Ventilators, Ultrasounds, Vital Sign Monitors, Wheel Chairs and Mobile Work Stations
- 5-minute cycle time is effective against *C. diff*, MRSA, VRE and other MDROs

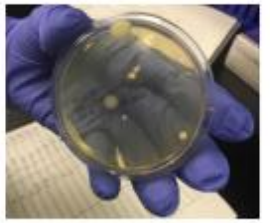
LightStrike Disinfection Pod™

- 30 PME were sampled before/after disinfection in the pod
- Results show that after a 5-minute disinfection cycle there was a 93% reduction in CFUs recovered from PME
- The reduction was statistically significant ($p<0.001$)





Wheelchair Handle - Before



Wheelchair Handle - After

In Closing

The environment is seemingly impossible to keep disinfected with manual cleaning alone.

Even one HAI is too many.

We Have a Solution

We Are Industry Leaders

- Over 400 hospitals across the U.S. and abroad
- We are anchored in science and committed to reduce suffering associated with HAIs

We Are Proven

- 24 peer-reviewed environmental and outcome studies to date and counting
- Xenex customers continue to realize substantial decreases in their infection rates and many are maintaining low rates through the maintenance program

We Are Safe

- Pulsed Xenon is environmentally friendly
- Proprietary, redundant safety features built into our LightStrike™ Robots
- We do not degrade surfaces and equipment

We Are Reasonably Priced

- Reliable, rapid cycle times mean you get more disinfections done in a day

XENEX®
DISINFECTION SYSTEMS™

THANK YOU